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(पहला पुनरीक्षण)

Indian Standard

WATER STAGE RECORDER (FLOAT TYPE) — SPECIFICATION

(First Revision)

ICS 17.120.20

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

November 2002 **Price Group 6**

Fluid Flow Measurement Sectional Committee, WRD 1

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Fluid Flow Measurement Sectional Committee had been approved by the Water Resources Division Council.

The stage of a stream at any given time is the height of the water surface at the time above an established datum. An accurate record of water stage (water level) provides an important part of the basic data necessary for computing the rates and quantities of flow at any period of time. In order that such measurements of water stage are reliable, the instruments, equipment and methods must be adopted to the local conditions prevailing at the gauging site, so that adequate data are available at the least practicable cost.

The water stage may be read from direct observations on a non-recording gauge or by the use of a recording gauge. Recording gauges are generally preferred in case of rivers where the changes between the low and high water stages and *vice-versa*, are very rapid and sudden, or for obtaining continuous and indisputable records of water stage variations. Another merit of recording gauges is that the results obtained are free from personal errors or bias. Also, the recording gauges prove to be advantageous at places not easily accessible.

There are different types of recording gauges. Their basic function is to produce a graphic or printed record of the rise and fall of the water surface in relation to time. They consist of a time element and a gauge height element which when operated together, produce on a chart record of the variations of the water level with respect to time. The mechanism to register time is operated by a clock. They may be classified as:

a) Float operated, and

b) Hydrostatic-pressure operated.

This standard was first published in 1979. In this first revision certain modifications have been affected in the clauses relating to the functional requirements of 'float line' in order to avoid error due to slipping of float line over float pulley, apart from carrying out other editorial modifications.

Functional requirements of 'vertical' staff gauges' are separately covered in IS 4080 : 1994. Both IS 4080 and IS 9116 have derived assistance from ISO 4373 'Measurement of liquid flow in open channels — Water-level measuring devices'. The technical committee opined to continue these two Indian Standards as well as to adopt ISO 4373 : 1995 which has since been printed as IS 15118 : 2002 'Measurement of liquid flow in open channels — Water-level measuring devices'.

This standard is one of the series of Indian Standards in the field of instruments used in stream gauging. Other standards in the series are:

IS 3910 : 1992	Requirements for water flow measurement in open channels — Rotating element current meters (*first revision*)
IS 3911 : 1994	Surface floats — Functional requirements (*first revision*)
IS 3912 : 1993	Sounding rods — Functional requirements (*first revision*)
IS 3913 : 1966	Specification for suspended sediment load samplers (under revision)
IS 3917 : 1966	Specification for scoop type bed material samplers (under revision)
IS 3918 : 1966	Code of practice for use of current meter (cup type) for water flow measurement
IS 4073 : 1967	Specification for fish weights
IS 4080 : 1994	Vertical staff gauges — Functional requirements (*first revision*)
IS 4858 : 1968	Specification for velocity rods

(*Continued on third cover*)

Indian Standard

WATER STAGE RECORDER (FLOAT TYPE) — SPECIFICATION

(First Revision)

1 SCOPE

This standard covers the functional requirements, materials for manufacture, performance tests, installation, operation and maintenance, the forms for records, for the float-operated water stage recorders used in stilling (gauge) wells. Typical details of a water-stage recorder are provided in Annex A to serve as an example.

2 REFERENCES

The Indian Standards listed below contain provision which through reference in this text constitute provisions of this standard. At the time of publication, the editions indicated was valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
736 : 1986	Wrought aluminium and aluminium alloy plate for general engineering purposes (*third revision*)
1550 : 1967	Copper sheet and strip for utensils and for general purposes (*first revision*)
4080 : 1994	Vertical staff gauges — Functional requirements (*first revision*)

3 GENERAL DESCRIPTION

3.0 General

The float gauge is used chiefly as an inside reference gauge in water-stage measurements. The typical float gauge consists of a float operating in a stilling well, float line, a counterweight, a pulley, and a pointer. The float pulley is grooved on the circumference to accommodate the tape, and mounted on a support. The tape is fastened to the upper side of the float and runs slip-free over the pulley in the gauge shed above the well. It is kept tight by a counterweight at the free end or by a spring. In this way stage fluctuations are sensed by the float which positions the float line with respect to the pointer.

3.1 Stilling Well and Intakes

The stilling well, usually set in the bank of the river and connected to it by one or more intakes (but sometimes placed directly in the stream) accommodates and protects the float and eliminates (or at least reduces) the effect of surface waves and short period surging in the natural channel.

3.2 Gauge Height Element

3.2.0 *General*

The gauge height element consists of all parts and systems designed to transfer the stage to a recording mechanism. It would thus consist of:

a) float,
b) float line,
c) float pulley,
d) counterweight, and
e) gauge scale mechanism.

3.2.1 *Float*

The float is cylindrical in shape. The size required depends upon the mechanical work involved and the accuracy of the registration desired.

To reduce the ratio of inertia and frictional resistance in the gauge height element, to active force represented by the buoyancy of the float, floats of reasonably large dimensions are used.

Generally floats vary from 125 to 300 mm in diameter. Larger sizes are recommended for nearly 1:1 or 1:2 ratios of recording. One set of typical sizes of floats is given in Annex B for guidance.

3.2.2 *Float Line and Counterweight*

A float line attached to a float resting on the water surface passes over the float pulley and has a counterweight to maintain proper tension. The float pulley is thereby turned during changes in water levels, which motion is imparted to the stylus (or drum or encoder) through gearing so as to record proportional increases or decreases in stage.

3.2.3 *Gauge Scale Mechanism*

The gauge scale mechanism consists of float pulley and gearing mechanism which offers different ratios for the gauge height element.

3.3 Time Element

The time element consist of a clock mechanism. In analogue recorders the clock mechanism is used to drive either a drum or chart paper, or the registering device. While driving a drum, recording can be up to any desired time depending only on the length of the chart paper on which the level is registered. In the latter case, the recording period is restricted to the available range of movement of the registering device. The clock mechanism can be any one of the following:

a) Spring-driven type (normally for 8 days),
b) Weight -driven,
c) Battery operated,
d) Electrically-operated, and
e) Crystal clock type (for very high precision).

In case of digital recorder, the timing mechanism programs the interval at which data are recorded.

3.4 Recording Mechanism

The recorder may be either analogue or digital. The analogue recorder produces a graphic record of the rise and fall of parameter values with respect to time, while the digital recorder punches coded parameter values on paper tape at pre-selected time intervals. Analogue recorders can further be classified into two types, those which record continuously or those which record for a fixed period of time (daily, weekly, monthly, etc). Digital recorder is used when the data is to be processed by digital computers.

4 FUNCTIONAL REQUIREMENTS

4.1 Stilling Well and Intake Pipes

4.1.1 *Stilling Well*

4.1.1.1 Stilling well shall provide within itself an accurate representation of the water level in the river (*see* Annex C).

4.1.1.2 It shall dampen out oscillations of the water surface.

4.1.1.3 The well and all construction joints of well and intake pipes shall be watertight so that water can enter or leave only by the intake itself.

4.1.1.4 It shall be vertical within acceptable limits and have sufficient height and depth to allow the float to travel freely the full range of water levels.

4.1.1.5 The cut-off wall around the stilling well, where required, shall be provided to prevent it from scouring action.

4.1.1.6 Top of stilling well shall be well above the observed maximum flood level (at least 1.50 meter free board may be provided).

4.1.1.7 Safe and convenient access to the site shall be available throughout the year.

NOTE — For further details, *see* 7.

4.1.2 *Intakes*

4.1.2.1 It shall allow water to enter or leave the stilling well so that the water in the well is maintained at the same elevation as that in the stream under all conditions of flow.

4.1.2.2 It shall permit some form of control to limit lag and oscillating effects within the pipe well.

4.1.2.3 The dimensions of the intakes shall be large enough to allow the water level in the well to follow the rise and fall of river stage without appreciable delay.

4.1.2.4 The dimensions of the intakes shall be large enough to damp oscillations caused by wave action or surges.

NOTE — These requirements are opposed and a suitable balance must be achieved. For example, to effectively eliminate surging it may be necessary to restrict the cross-sectional area of the intakes to 0.1 percent of the cross-sectional area of the well whereas to reduce the lag effect to acceptable limits, the ratio may have to be at least 1 percent. This will depend on site conditions, the type and length of intakes and the surface area of the well. Because of this, no firm rule can be laid down for determining the best size of intake but it is advisable to make the connection too large rather than too small as a restriction can be added if found necessary. As a general guide the total cross-sectional area of the intake should not be less than 1 percent of the cross-sectional area of the well.

4.1.2.5 The intake shall be so oriented in the stream that it will sense the true water level. When velocities in the stream at the point of measurement are sufficiently large that the dynamic pressure is of sensible magnitude, the intake shall incorporate a static pressure sensing device (wall piezometer, piezometer in a plate, surface parallel to flow, static tubes, etc).

NOTE — For further details, *see* 7.

4.1.2.6 The mouth of intake shall be provided with wire mesh and positioned in such a way that the entry of weeds, debris, etc, gets prevented.

4.2 Float Gauge Installation

4.2.1 A float gauge installation shall permit measurement of stage to be made at all levels from below the lowest to above the highest level anticipated.

4.2.2 For the measurement of stage, in certain installations and accuracy of ±10 mm may be satisfactory; in others an accuracy of ±3 mm or better may be required; however, in no case should the accuracy be worse than ±10 mm or ±1 percent of the range whichever is greater.

4.3 Gauge Height Element

4.3.1 *Float*

4.3.1.1 It shall be leak proof.

4.3.1.2 It shall have maximum stability.

NOTE — A depth of submergence of about half its height is recommended.

4.3.2 *Float Line (Chain or Cord or Wire or Tape)*

4.3.2.1 Its extension due to weight of float and counterweight shall be insignificant.

4.3.2.2 It shall be graduated.

4.3.2.3 The movement of the float line on the pulley shall be free from slip and the total cumulative slip (line shift error) over 8 days shall not exceed 0.025 percent of the maximum range or 3 mm whichever is more. The error due to slipping of float line over float pulley can be avoided by using perforated metallic tape (carrying float and counterweight at the two ends) passing over a float pulley having cone shaped spikes at its circumference. The arrangement is shown schematically in Fig. 1. The centre to centre distance — shown as 'pitch' in Fig. 1 between two consecutive holes on the tape is made equal to the circumferential centre to centre distance between two consecutive spikes on the pulley. As the float moves with water level, the perforated tape also moves. The perforations on the tape engage with the spikes on the pulley and rotate it without any slippage.

4.3.3 *Gauge Scale Mechanism*

4.3.3.1 The pulley shall have recesses or spines to engage the beads or perforations of the float line, in such a way as to prevent any slip.

4.3.3.2 There shall be provision to permit a choice of at least two ratios and it shall be possible to change the scale easily in the field.

4.3.3.3 The torque due to the driving force (supplied by the displacement of float due to water) shall be below 7×10^{-3} N.m (that is the frictions in mechanical linkage shall be low).

4.3.3.4 The hysteresis (lost motion) due to mechanical linkage shall be low.

4.3.3.5 The spindle (input shaft) shall be horizontal and means for horizontal levelling of the spindle shall be provided.

4.4 Time Element

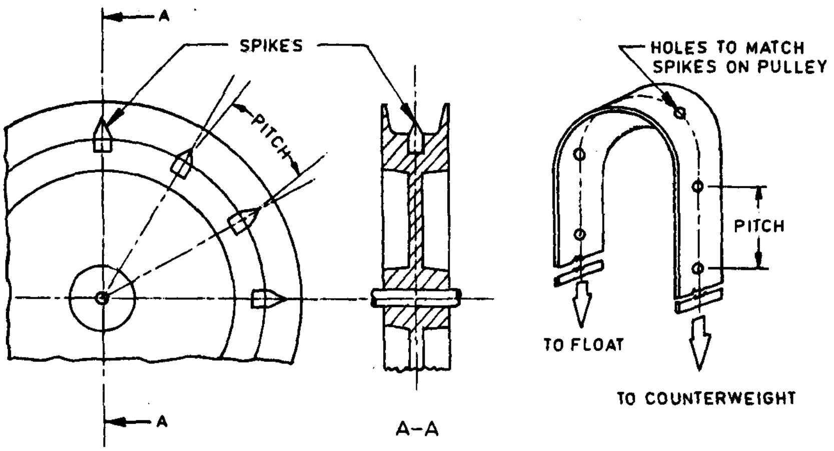
4.4.1 The clock shall be sturdy and reliable.

4.4.2 There shall be provision to permit a choice of at least two durations and it shall be possible to change the scale easily in field.

4.4.3 The accuracy of the clock shall be within ±30 seconds per day (cumulative) to be measured over a period of at least 30 days.

4.4.4 An adjustment device is to be provided to permit regulation within the above accuracy requirements.

4.4.5 Normally a time scale of 60 mm per day is required. However, in flashy rivers and other important investigations a time scale of 480 mm per day is required.



PULLEY WITH SPIKES

PERFORATED METALLIC TAPE

FIG. 1 ARRANGEMENT SHOWING PULLEY WITH SPIKES, PERFORATED TAPE

4.4.6 Additional clock shall be kept as standby during monsoon period.

4.5 Recording Mechanism

4.5.1 The recording mechanism shall be designed so as to permit ready adjustment of both the gauge height and time scales.

4.5.2 There shall not be any significant error due to the expansion or contraction of charts or punched tape due to change in temperature and humidity or any other error due to improper alignment and, therefore, the chart or tape shall have a proper casing with a window (for visual inspection without opening the case) which incidentally protects the instrument from dust and insects.

4.5.3 Pen used for recording shall be capable of holding sufficient ink for the period during which the chart is used and the ink shall be of a good quality so that a permanent record could be obtained. Pencil used, shall be of proper hardness to produce a legible record.

5 MATERIALS OF MANUFACTURE

5.1 Well and Intake

These shall be of any suitable non-corrodible and rust proof material.

5.2 Float Counterweight and Other Moving Parts

These shall be of rust proof and non-corrodible material.

5.3 Float Line

It shall be inelastic, rust-proof and of non-corrodible material.

5.4 Chart/Tape

Coefficient of hygroscopic expansion chart paper/tape shall be small (for example, 0.05 to 0.15 percent per 10 percent, RH).

6 PERFORMANCE TEST

6.1 Error Due to Friction

The error E, caused by friction in the driving mechanism calculated, in meters, from the following formula shall not exceed ± 0.2 mm:

$$E = \frac{F}{\pi R_1^2 R_2 \rho g}$$

where

F = the driving torque in Newton meters,

ρ = the density in kilograms per cubic meter,

R_1 = the radius of float in meters,

R_2 = the radius of pulley in meters, and

g = the acceleration due to gravity in meters per second square.

NOTE — This error applies fully, both to the rising stage and to the falling stage. It can be reduced by increasing the diameter of the float.

6.2 Line Shift

As the stage changes the amount of float line on one side of the float pulley against that on the opposite side also changes. This change of line, hence weight, changes the depth of floatation of the float which causes an error in the indicated stage. This error E, may be calculated, in meters, from the following formula and shall be within ±0.2 percent of the total change in level of float for which recorder is designed:

$$E = \frac{\pm 2W \Delta h}{\pi R^2 \rho}$$

where

Δh = the difference in stage in meters,

W = the weight of float line per meter,

R = the radius of float in meters, and

ρ = the density in kilograms per cubic meter.

As can be seen, this error may be plus or minus from point equilibrium, depending on whether the stage falls or rises.

6.3 Hysteresis (Lost Motion)

Usually either gear trains or sprockets and chains or a combination thereof form the mechanical linkage, and the play between the teeth of gears or the slack in the sprocket chain is the cause of this hysteresis. If the input shaft is rotated in one direction until the stylus follows and then the direction of rotation reversed, the total hysteresis is that amount of motion required to cause the stylus to follow in the reversed direction. It is desirable to keep such lost motion to a minimum but in no case should it exceed limits of accuracy, that is, 3 mm.

7 INSTALLATION

7.1 Stilling Well

7.1.1 The well may be circular, oval, square or rectangular in plan.

7.1.2 The well may be placed in the bank of a stream or directly in the stream when attached to a bridge pier or abutment. It shall not, however, be located directly in the stream where flow conditions would lead to separation and stagnation effects. When placed in the bank the well shall be connected to the stream by intake pipe(s). When placed directly in the stream, the intake may take the form of holes or slots cut in the well in itself.

7.1.3 The well shall not interfere with the flow pattern in the approach channel and if set in relation to a control, it shall be located far enough upstream or downstream to be outside the area affected; by the control.

7.1.4 The well shall be firmly founded when placed in the bank and firmly anchored when standing in the stream so that it shall remain stable at all times.

7.1.5 The dimensions of the well shall be such as to allow unrestricted operation of all equipment installed in it. Clearance between walls and float shall be at least 75 mm and where two or more floats are used within the well, clearance between them shall be at least 150 mm. In silt laden rivers it is an advantage to have the well large enough to be entered and cleaned.

7.1.6 When placed in the bank of the stream the stilling well shall have a sealed bottom to prevent seepage into or leakage out of the chamber.

7.1.7 In wells with sealed bottoms, the bottom of the well shall be at least 300 mm below the invert of the lowest intake to provide space for sediment storage and to avoid the danger of the float grounding at times of low flow.

7.1.8 In cold climates the well shall be protected from the formation of ice. This may be done by the use of well covers, sub-floors, heaters or oil on the water surface. When oil is used the oil surface will stand higher than the water level in the stream and a correction must be used when setting the recorder.

7.1.9 When the well is surrounded by water, there shall be two staff gauges, one in the well and the other outside, with their zero readings at the same level. Enamelled gauge, if used, shall be in accordance with IS 4080.

7.1.10 Ladder or steps shall be provided inside the well to give access to the bottom of the well.

7.1.11 The gauge well shall not have blunt ends at the upstream side, and shall be suitably rounded off.

7.2 Intakes

7.2.1 Intakes may take the form of one or more pipes connecting the well to the river when the well is set back into the bank or a series of holes or slots cut into the well itself when it is set directly into the river. In rivers with a permanent high silt content a well set in the stream may; have a hopper shaped bottom to serve as an intake and also as a means of self-cleansing.

7.2.2 Two or more intakes may be installed, one vertically above the other, to ensure operation of the system if the lowest pipe becomes blocked.

7.2.3 For a pipe well set into a bank the lowest intake shall be at least 150 mm below the lowest anticipated stage and shall enter the pipe well at least 300 mm above the well bottom. In cold climates this intake shall be below the frost line.

7.2.4 Intake pipes shall be laid at a constant gradient on a suitable foundation which will not subside.

7.2.5 It is desirable that intake pipes more than 20 m in length shall be provided with an intermediate manhole fitted with internal baffles to act as a silt trap and provide access for cleaning.

7.2.6 Means of cleaning the intakes shall be provided, either by a flushing system where water under several meters of head can be applied to the stilling well and of the intake, by pumping water through the intake or by hand cleaning with collapsible draining rods.

7.2.7 Where velocity past the river end of the intake is high, draw down of the water level in the well may occur. This can be reduced by attaching a capped and perforated static tube to the river end of the intake and extending it horizontally downstream.

7.3 Gauge Datum

The stage of a stream or lake is the height of the water surface above an established datum plane. The datum of the gauge may be a recognized datum such as mean sea level, or an arbitrary datum plane selected for the convenience of using gauge reading of relatively low numbers. It is generally desirable to avoid negative values for these readings, therefore the datum selected for operating purposes shall be below the elevation of zero flow on the control.

If an arbitrary datum plane is used, it shall be referred to a bench mark of known elevation above sea level by accurate levelling so that the arbitrary datum may be recovered if the gauge and reference marks are destroyed. A permanent datum must be maintained so that only one datum for the stage record is used for the life of the station.

7.3.1 *Gauge Zero*

The zero of the gauge shall be correlated with a national datum through a station bench mark. The relation between the gauge zero and the station bench mark shall be checked at least annually. Also, the relation between the gauge zero and other divisions shall be checked from time to time. The tolerance on the transfer of the level from the station bench mark to the gauge shall not exceed ±1.0 mm .

7.3.2 *Station Bench Mark*

The station bench mark shall be set in a position offering maximum security against disturbance. It shall be securely fixed in a concrete block or similar mounting that extends below the ground surface to a level free from disturbance, such as frost. It should be correlated with a national survey datum by accurate levelling. To facilitate accurate levelling between the station bench mark and the gauge zero, the bench mark should be located in a position such that the transfer of the level may be carried out by reciprocal levelling or with equally balanced foresights and back sights on the setting of the level.

7.4 Recorder

The recorder shall be housed in a ventilated, weather-proof and lock-fast hut, constructed on a thoroughly stable foundation, and of such dimensions as will permit the entry of the observer and give him protection from the weather during the operations of changing the chart and servicing the instrument. The recorder shall be mounted on a rigid stool or table firmly fixed to the foundation of the hut and independent of the main structure of the building. All operating equipment shall be inside the hut.

8 OPERATION AND MAINTENANCE

8.1 A general operational manual shall be provided by the manufacturer with such descriptions and diagrams as necessary for proper operation and maintenance of the recorder, together with a list of accessories and spares.

8.2 In addition the following instructions shall be carried out:

a) The local observer shall visit the station at appropriate intervals to ensure regular servicing of the recorder.

b) If possible, additional visits shall be made throughout the period to verify that the recorder is operating satisfactorily.

c) The local observer shall be required to record observation of the water level on the 'reference gauge' and also the time for comparison with the recorder chart and clock.

d) The observer may mark the chart by slightly raising or lowering the float wire to relate the reading to the chart trace.

e) The local observer shall record any obstruction of the channel by weeds, shall note any casual obstruction of the channel by flood debris or from any other cause, and keep the site and equipment generally clean and tidy, paying particular attention to the legibility of the 'reference gauge'.

f) All records or charts shall be immediately completed and dispatched to the record office for computation together with any relevant notes or observation.

g) The Gauging Station shall be inspected by a superior officer, whenever any incident which might affect its accuracy is notified by the local observer.

h) Recorders which are otherwise in good working order shall be thoroughly cleaned (on the site, if necessary) at least once a year.

j) Clocks shall be removed for overhaul by a clock-maker at intervals if not greater than two years.

k) A non-corrosive dehydrant may be used in the instrument case to absorb moisture.

9 RECORDING

A typical proforma for inspection of the recording gauge is given at Annex D in order to highlight the points requiring attention.

10 MARKING

10.1 Each water-stage recorder shall bear the manufacturer's name and date of manufacture.

10.1.1 *BIS Certification Marking*

The product may also be marked with the Standard Mark.

10.1.1.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. Details of conditions under which a license for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

ANNEX A

(*Clause* 1)

TYPICAL DETAILS OF A WATER-STAGE RECORDER

A-1 GENERAL SET UP OF THE RECORDER

The general arrangement of the stilling well and recorder is shown in Fig. 2.

A-2 WATER STAGE RECORDER

The details of the recorder are shown in Fig. 3.

A-3 DETAILS OF ASSEMBLY

Over the bed plate (1) suitable provisions should be made for mounting:

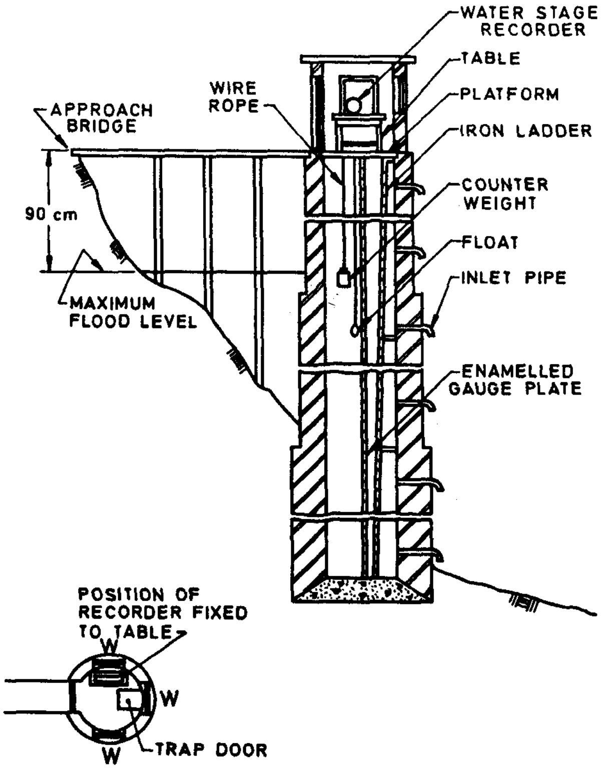
a) the cover (2),
b) the recording drum (3),
c) the threaded spindle (7), and
d) the clock-work (9).

The cover (2) has a glass window. The drum (3) has the recording paper on it and is driven by the lock mechanism (9) with suitable reduction gear (10). The drum shaft has ball bearings (4) to make it run smoothly. The cable with the water-tight float (11) suspended on it runs over the pulley (5) mounted on the threaded spindle (7). When the spindle revolves, it causes a movement of the pen (8) proportional to the change in water level of the stilling well. The cable, with counter weight (12) suspended on it, may run over a pulley of smaller diameter so that the counter weight movements are limited to a minimum, thus preventing it from immersing at the highest liquid level.

A-4 MATERIALS

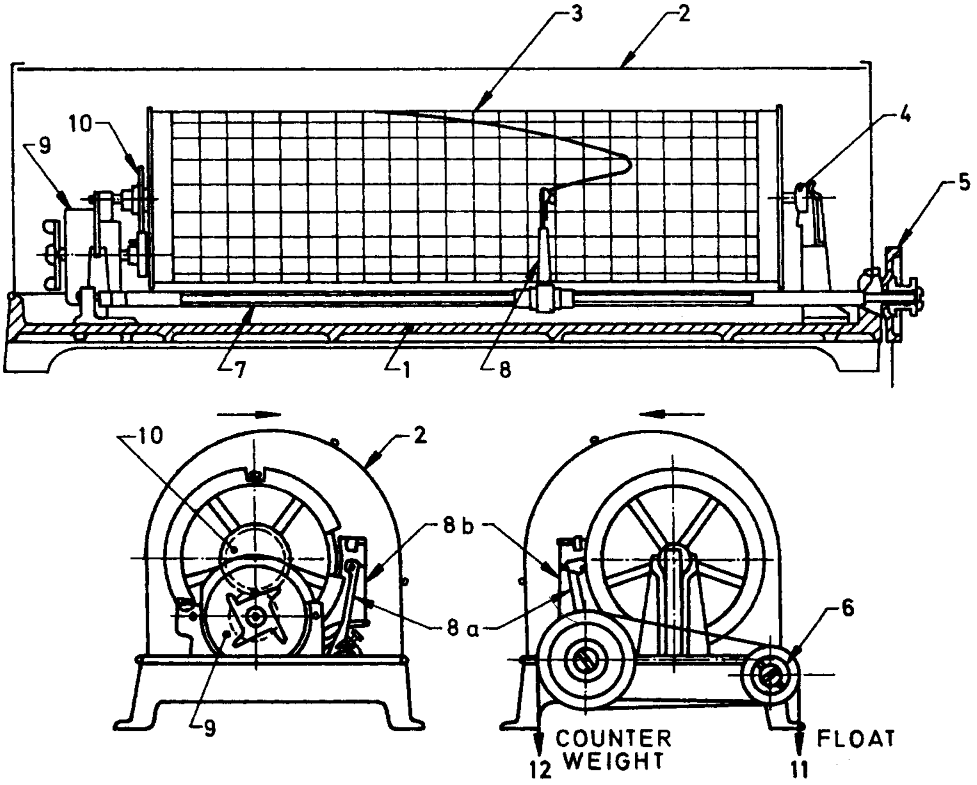
Generally, the materials should be rust-proof and free from corrosion. The following are only typical examples of the materials used for some of the parts:

a) *Base Pate* — material of light weight, like aluminium conforming to IS : 736, with suitable treatment against corrosion.
b) *Spring of Clock Mechanism* — should be anti-magnetic.
c) *Reduction Gear* — gun metal.
d) *Cable* — should be inelastic, non-rusting material such as or galvanized iron or brass or stainless steel.
e) *Float* — may be of copper conforming to IS 1550.
f) *Counter Weight* — gun metal.



Plan of Platform

FIG. 2 WATER-STAGE RECORDER IN A GAUGE WELL



1 — Bed Plate, 2 — Cover, 3 — Recording drum, 4 — Ball Bearing, 5, 6 — Pulleys, 7 — Threaded Spindle, 8 — Pen, 9 — Clock-Work, 10 — Reduction Gear, 11— Float, 12 — Counterweight

FIG. 3 WATER LEVEL RECORDER WITH A HORIZONTAL AXIS (A. OTT TYPE)

ANNEX B

(*Clause* 3.2.1)

DETAILS OF GAUGE SCALES AND FLOAT SIZES

Scale Designation	**Pitch Circumference or Float Pulley** mm	**Graph Change per Meter of Water Change** cm	**Water level Change for 1 Traverse of Stylus Across Chart**		**Recommended Size of Float** mm
			24-cm Chart m	50-cm Chart m	
(1)	(2)	(3)	(4)	(5)	(6)
1 : 1	375	100	0.25	0.5	300
1 : 2	750	50	0.50	1.0	300
1 : 5	375	20	1.25	2.5	200
1 : 10	750	10	2.5	5.0	200
1 : 10	375	10	2.5	5.0	200
1 : 20	750	5	5.0	10.0	200
1 : 25	375	4	6.25	12.5	200
1 : 50	750	2	12.5	25.0	200

ANNEX C

(*Clause* 4.1.1)

STILLING WELL

C-1 STILLING WELL LAG

Where a stilling well is connected to the river by an intake pipe the diameter of the intake shall be large enough for the water in the well to follow the rise and fall of stage without delay. When discharge in a river increases, the water level in the channel rises and water flows from the channel into the stilling well. If this flow is appreciable, head losses in the connecting pipe including any control fittings used (valves, outlet tees, static tubes, etc) can cause a difference between the water level in the river and that in the well. This is due to stilling well lag and, for any given combination of well size, intake size and control fittings, the magnitude will be a function of the rate of change of stage. For a given rate of change of stage the amount of lag can be determined by the relationship:

$$Sh_1 = \frac{C_f}{2g}\left(\frac{A\omega}{Ap}\right)^2\left(\frac{dh}{dt}\right)^2$$

where

C_f = the coefficient of head losses in connecting pipe and fitting,

Sh_1 = the amount of lag in meters,

g = the acceleration of gravity in meters per second square,

$A\omega$ = the horizontal cross-sectional area of stilling well in square meters,

Ap = the cross-sectional area of intake pipe in square meters, and

$\frac{dh}{dt}$ = the rate of change of stage in the river in meters per second.

C-1.1 For a single, straight connecting pipe with no control fittings the losses are :

$$\left.\begin{aligned}\text{Entry loss} &= 0.5\,\frac{V^2}{2g}\\ \text{Exit loss} &= 1.0\,\frac{V^2}{2g}\\ \text{Friction loss} &= 4\,\frac{fL}{D}\,\frac{V^2}{2g}\end{aligned}\right\} W_L = \left[1.5 + \frac{4fL}{D}\right]\frac{V^2}{2g}$$

where

W_L = total head loss, in meters;

f = the Darcy-Weirbach coefficient of total drag;

L = the length of intake pipe in meters;

D = the diameter of intake pipe in meters;

V = velocity in meters per second; and

g = the acceleration due to gravity in meters per second square.

ANNEX D

(*Clause* 9)

TYPICAL *PRO FORMA* FOR INSPECTION OF RECORDING GAUGE

Date.............................

.................................River, at...

....

1) Was gauge working properly when; you reached it ? ....

2) What is correct time by your watch ? ....

3) What is the clock time ? ....

3a) Have you checked the operation of the clock as per the instruction ?[1]

4) What is the time by the pen or pencil ? ....

5) What is the outside or river-gauge reading ? ....

6) What is the inside or well-gauge reading ? ....

7) What is the recording-gauge reading ? ....

8) Have you marked pen or pencil time on the chart by raising the float ? ....

....

9) Did you remove old sheet and put on new one ? .... At what time did you do this ? ....

10) If you did not remove sheet, did you correct setting of pen or pencil and clock ? ....

....

11) Did you wind clock ? .... Regulate it ? ....

12) Did you sharpen pencil or fill pen? ....

13) Did you mark pen or pencil time on new sheet by raising float ? ....

14) Have you filled blanks on old sheet according to instructions ?[2] ....

15) Have you made sure that pen or pencil is down, sheet placed correctly setscrew on drum fastened and gauge working correctly before leaving station ? ....

16) Have you filled all blanks on this sheet according to instructions ?[2] ....

....

17) Have you recorded water level observations and time on the reference gauge ?

....

Remarks and questions..

Signed by ....

Observer

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[1] in manufacturers' manual.

[2] from the department.

ANNEX E

(*Foreword*)

COMMITTEE COMPOSITION

Fluid Flow Measurement Sectional Committee, WRD 1

Organization	*Representative(s)*
Central Water Commission, New Delhi	Shri S. K. Das (***Chairman***)
AIMIL Private Ltd, New Delhi	Shri S. C. Jain Shri K. S. Subramaniam (*Alternate*)
Bhakra Beas Management Board, Punjab	Director (WR) Senior Design Engineer (WR) (*Alternate*)
Central Water and Power Research Station, Pune	Shri A. R. Chavan Shri B. S. Kulkarni (*Alternate*)
Central Water Commission, New Delhi	Shri S. K. Sengupta Director (P & D) (*Alternate*)
Consulting Engineering Services (India) Private Ltd, New Delhi	Shri T. S. Bathija Shri S. S. Narang (*Alternate*)
Fluid Control Research Institute, Palghat (Kerala)	Dr Nagaraj Sitaram Shri Jacob Chandapillai (*Alternate*)
Indian Institute of Science, Bangalore	Dr K. Sridharan
Irrigation Department, Government of Andhra Pradesh	Director (ERS)
Irrigation Department, Government of Uttar Pradesh	Director (IRI) Chief Engineer (Ganga) (*Alternate*)
Irrigation Department, Government of Punjab	Chief Engineer (IPRI) Research Officer (IPRI) (*Alternate*)
Irrigation Department, Government of Karnataka	Director (ERS)
Indian Institute of Technology (Department of Civil Engineering), Roorkee	Dr G. L. Asawa
Ministry of Railways (RDSO), Lucknow	Joint Director (Standards) Deputy Director (Standards) (*Alternate*)
National Hydroelectric Power Corporation Ltd, Faridabad	Shri Shankracharya Shri Rajiv Babоота (*Alternate* I) Shri Anil Bhatnagar (*Alternate* II)
National Institute of Hydrology, Roorkee	Director Dr P. K. Mohapatra (*Alternate*)
National Physical Laboratory, New Delhi	Research Officer Director (*Alternate*)
Electronic Equipments, Pune	Shri V. R. Munagekar Shri S. R. Munagekar (*Alternate*)
In personal capacity [*425/14 T. V. Nagar, Pune 411 037, (Maharashtra)*]	Dr S. V. Chitale
BIS Directorate General	Shri S. S. Sethi, Director & Head (WRD) [Representing Director General (*Ex-officio*)]

Member Secretary
Shri S. S. Sethi
Director (WRD), BIS

(*Continued from second cover*)

IS 14359 : 1996	Echo sounders for water depth measurements
IS 14973 : 2001	Measurement of fluid flow in closed conduits — Velocity area method using Pitot static tubes
IS 15117 : 2002	Hydrometric determination — Cable way system for stream gauging
IS 15118 : 2002	Measurement of liquid flow in open channel — Water level measuring devices

Work is in progress in the formulation of the following new Indian Standards in the field of instruments used in stream gauging:

a) Liquid flow measurement in open channels — Position fixing equipment for hydrometric boats (adoption of ISO 6420 : 1984), Doc.1 (344)

b) Measurement of liquid flow in open channels — Equipment for the measurement of discharge under ice conditions (based on ISO/TR 11328 : 1994), Doc.1 (359)

c) Hydrometric determinations — Unstable channels and ephemeral streams (based on ISO/TR 11332 : 1998), Doc. 1 (361)

The composition of the Committee responsible for the formulation of this standard is given in Annex E.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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